

REVIEW

Trends in Alloplastic Replacement of Segments of the Urinary Tract

Jean Auvert

Hôpital Henri Mondor, Creteil, Paris, France

Received: May 31, 1976

I. REPLACEMENT OF THE URETER BY A SILICONE RUBBER TUBE

Until now only a flap of the bladder or a loop of ileum have been used for either partial or total replacement of the ureters. Ureteric substitution by synthetic tubing would be an economical solution for ureteric replacement and would impose the smallest surgical risk upon the patient.

Prior to the recent use of silicone rubber all the previous results with tantalum, latex and polyethylene have been disappointing. The first attempts using polyethylene, gave poor results (10, 11, 14, 15). Better results of short duration were reported using PTFE tubing (12, 18). Silicone prostheses were used by Blum et al. and Sankey (4, 5, 17). Auvert et al. have used a combined silicone textile graft since 1968 (1, 2, 9). In 1966, Kohler (13) reviewed the literature concerning ureteric substitution by synthetic prostheses and concluded that plastic material was not suitable for permanent replacement of the urinary tract. The same opinion was given by Lhez in his report to the French Urological Association in 1968 (16).

In our experiments, we have used a prosthesis of silicone rubber (polydimethyl siloxane), Scurasil^R, (manufactured by Rhone-Poulenc). These artificial ureters are 15 to 25 cm in length and 5 to 9 mm in external diameter. The inner surface is smooth and lacquered to prevent any calcification. To facilitate fixation, both ends are covered with a velvet sleeve of polyethylene glycol terephthalate (Rhodergon^R). The ends of the tube are inserted into the upper part of the ureter and the bladder. Sutures on the sleeve prevent migration of the tube. An anti-reflux valve is currently being tested. To prevent vesico-ureteric reflux we have incorporated a double leaf anti-reflux valve made

with two thin silicone sheets. On the bench, this valve allows a direct 10 ml/min flow with a pressure drop of less than 1 cm of water. The back flow is lower than 1 ml/min with a reverse pressure of 40 cm of water. The leaflets should not reverse under a pressure of 80 cm of water. To prevent migration of the tube either distally into the bladder or proximally into the pelvis of the kidney a new prosthetic tube was designed with a spiral shape and this has proved to be more stable.

A. Experimental in Dogs

More than 72 ureters in dogs have been operated upon during the past 6 years. Several animals have shown good results at one year, some living more than two years. The best technique is the intubation of the prosthesis into the ureter and this has given a 60% success rate. No incrustation or stone formation has been noted. Microscopic examination has revealed a thin layer of flat endothelial cells covering the outside of the tube, but without any muscular layer. If the prosthesis is removed, even after one year, the ureter-like conduit collapses and stenosis occurs.

B. Clinical Application

At the present time, only neoplastic stenosis of the ureter represents an acceptable indication for a prosthesis. It is better tolerated by the patient than either a nephrostomy or ureterostomy. Replacement by an ileal loop is often too major a procedure in the patient with advanced malignancy. The prosthesis may also

be used in cases of necrosis following radiation therapy.

The exact type of prosthesis may be selected pre-operatively on the basis of X-ray studies but is preferably chosen at the time of surgery.

These prostheses have not been used in cases other than malignancy and they should be used only in the following circumstances:

- if the bladder is normal.
- in unilateral disease of the ureter, where the ureter cannot be repaired by another method.
- in an older patient in whom the use of ileum seems too dangerous or where nephrectomy is not indicated.
- in bilateral disease where the patient refuses urinary diversion and when life expectancy is less than two years.

It is possible to replace either the whole of the ureter or the upper, middle or the pelvic segments. Recently, Blondel and Dufour succeeded in replacing only the upper or middle part of the ureter, keeping the pelvic ureter in situ (3). The results in 18 dogs led them to use the prosthesis in two patients with good results after one year; the initial diseases were tuberculosis and bilharziasis of the ureter.

A more recent use of the ureteric prosthesis is to make a cutaneous ureterostomy. The silastic tube is anastomosed to the upper part of the short ureter and brought out onto the surface of the skin where it is connected to a drainage bag.

The collected experience from different groups working in Paris with these ureteric prostheses, now totals 50 patients in whom the ureter has been either replaced totally or partially.

In the first group of 17 patients, the prosthesis was used to avoid the inconvenience of a cutaneous urinary diversion in cases of acute renal failure. All the patients had bilateral obstruction of ureters and anuria due to advanced genito-urinary malignancy and all had short life expectancy. Survival following this procedure was short (between 2 and 8 months) and death was always due to extension of the carcinoma.

In a second group of 33 patients, 38 prostheses were implanted. The cause of the chronic ureteric stenosis was either recurrence of carcinoma of the uterus, rectum, colon or prostate or due to fibrosis (11 cases). In those patients with uterine carcinoma, the fibrosis was often increased by irradiation. Of these 33 patients only 7 showed good results of longer than 6 months and only 2 of greater than one year.

II. REPLACEMENT OF THE URETHRA BY A SILICONE RUBBER TUBE

A. Experimentation in Male Dogs (7)

The following experimental work has been carried out by Court and Arvis in 27 dogs during the past 18 months (6).

Material and Technique. The tube used was similar to the one used for replacement of the ureters and is made of pure silicone with a sleeve of velvet at each end. A spiral prosthesis that will adjust better to the sub-pubic angle is being developed. It is easier to replace only the middle part of the urethra in the male dog, i. e. distal to the prostate and proximal to the penis with its bone. A segment of the urethra is resected and withdrawn and the prosthesis is then inserted into the two ends of the urethra. Arvis has used a similar procedure but his prosthesis is completely covered with Rhodergon^R velvet to secure the position of the new urethra.

Results. In 27 dogs there were two deaths and three failures due to stenosis in one and fistulae in two. The results in the remaining 20 studies were satisfactory as judged by normal micturition, good urinary flow and no infection. The prostheses have been maintained in place from 5 to 16 months. In five cases where the prosthesis was removed or fell out, micturition was good without dysuria. It is interesting to note that in one case when the prosthesis was removed, after a further 6 months, micturition remained possible through the new urethra in which histological examination revealed a new epithelium-like layer. There was no late stenosis.

B. Clinical Application

Two spiral shaped tubes have been placed in patients following severe post-traumatic strictures of the posterior urethra. In one, the tube functioned well for one year, but then required removal due to obstruction by calcification and stones. The second tube has functioned well for 8 months. These tubes are known to have been used in 5 further patients with encouraging results, though the follow-up is short (8).

III. PROSTHETIC REPLACEMENT OF THE BLADDER

The high incidence of invasive bladder carcinoma leading to a total cystectomy combined

with irradiation has resulted in a major problem concerning urinary reconstruction and diversion. Bilateral cutaneous ureterostomy, ureterosigmoidostomy and the ileal loop as bladder substitutes have not proved to be totally satisfactory solutions.

A. Orthotopic Experimental Bladder Prosthesis

An orthotopic bladder prosthesis has been developed by the research laboratory of Rhone-Poulenc. The ovoid-shaped bladder is made of specially treated Scurasil^R with an adequate bistable shape, i.e. it is stable either when empty or full. There is an opening at the lower pole to correspond with the internal meatus. Near the base two spiral tubes representing the ureters are implanted.

This model of bladder has been used in 8 female dogs for replacement after total cystectomy. The artificial bladder empties through the normal urethra with its spincters.

The results are based on survival times between 1 and 12 months. The function of the prosthetic bladder was often disturbed by a leakage around the bladder neck but most of these dogs lived with normal urograms and good urinary continence.

B. Heterotopic Bladder Prosthesis

Another type of prosthesis has been developed as an heterotopic bladder substitute to be used as a conduit. This bladder is placed in an iliac fossa intra-peritoneally and drainage is through a transparietal tube which is fitted with an obturator system to prevent leakage. In our experience with two patients, survival was only 4 months and leakage from one ureteric connection required reoperation.

REFERENCES

1. Auvert, J., Xerri, A., Benckroun, A., Dufour, B., Farge, C.: Remplacement d'un segment d'uretère par un tube d'élastomère de silicone chez le chien. *Journal d'Urologie et de Nephrologie* 75, 221 (1969)
2. Auvert, J., Xerri, A., Broc, A., Dufour, B.: Application clinique de remplacement expérimental de l'uretère par tube d'élastomère de silicone. *Journal d'Urologie et de Nephrologie* 76, 734 (1970)
3. Blondel, P., Dufour, B.: Remplacement segmentaire de l'uretère lombo-iliaque par une prosthèse en silicone. *Journal d'Urologie et de Nephrologie* 79, 249 (1973)
4. Blum, J. A.: Permanent silastic ureteral prosthesis. *Science Forum* 13, 501 (1962)
5. Blum, J. A., Skemp, C., Reiser, M.: Silicone rubber ureteral prosthesis. *Journal of Urology* 90, 276 (1963)
6. Court, B.: Personal communication (1976)
7. Court, B., Auvert, J., Sausse, A., Diep, K.: Remplacement d'un segment de l'urèthre par un tube élastomère de silicone chez le chien mâle (note préliminaire). *Journal d'Urologie et de Nephrologie* 78, 562 (1972)
8. Court, B., Xerri, A., Auvert, J.: Remplacement de l'urèthre chez l'homme par une prothèse en élastomère de silicone. *Journal d'Urologie et de Nephrologie* 79, 643 (1973)
9. Dufour, B., Auvert, J.: Le remplacement de l'uretère par une prosthèse d'élastomère de silicone. Résultats 3 ans d'expérimentation chez le chien. *Journal d'Urologie et de Nephrologie* 77, 444 (1971)
10. Furey, C. A.: Plastic ureteral valves in dogs. *Journal of Urology* 85, 525 (1961)
11. Hardin, C. A.: Experimental repair of ureters by polyethylene tubing and ureteral and vessel grafts. *Archives of Surgery* 68, 57 (1954)
12. Koevara, S., Zak, F.: Ureteral substitution with Dacron and Teflon prosthesis. *Journal of Urology* 88, 365 (1962)
13. Kohler, F. P.: The use of plastic materials as conduits in the urinary tract. *Journal of Urology* 97, 544 (1967)
14. Kohler, F. P., Murphy, J. J.: Experimental evaluation of a plastic mechanical ureteral valve. *Journal of Urology* 84, 293 (1960)
15. Lachand, A. T.: Sur les remplacements totaux de l'uretère. These, Paris (1970)
16. Lhez, A.: Les remplacements de l'uretère. Rapport Annuel au congrès de l'association Française D'Urologie, Paris (1968)
17. Sankey, N. E., Heller, E.: The results of ureteroplasty using a silicone rubber patch. *Journal of Urology* 97, 309 (1967)
18. Ulm, A. H., Krauss, I.: Total unilateral Teflon ureteral substitute in the dog. *Journal of Urology* 83, 575 (1960)

Professeur Jean Auvert
Hôpital Henri Mondor
F-94010 Creteil
France